



## Guest Editorial Special Issue on Power Quality in Smart Grids

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# Guest Editorial

## Special Issue on Power Quality in Smart Grids

Smart grid (SG) is usually described as a power system utilizing information and communication technology (ICT) and advanced monitoring systems to improve the grid performance and offer a wide range of additional services for the consumers. Some of the main features of such a grid are self-healing from power disturbances, efficient energy management, automation based on ICT and advanced metering infrastructures (smart metering), integration of distributed power generation, renewable energy resources and storage units as well as high power quality and reliability. In this regard, microgrid concept is brought to the stage as one of the main building blocks of the future SGs.

In the context of SG, Power Quality (PQ) has emerged as one of the most important issues. Although PQ is not a new topic in electrical systems, it deserves especial attention in modern grids mainly due to the following reasons:

- Increasing application of sensitive loads and control processes in recent years
- Proliferation of different nonlinear and single-phase loads which may adversely affect the PQ.
- Availability of advanced metering, sensing and control functionalities in SGs which can be utilized to provide a desirable PQ level for consumers.

Thus, measurement, analysis, and compensation power quality problems (e.g. harmonics, resonances, unbalances, sags, flickers, and so on) are of great importance.

In Special Issue on Power Quality in Smart Grids, we have nine high-quality papers that cover the following four topics:

- Analysis of power quality problems
- Control Schemes for enhance power quality
- Advances methods for power quality assessment
- Synchronization techniques

These topics and the papers included are explained in the following sections of this Guest Editorial.

### I. ANALYSIS OF POWER QUALITY PROBLEMS

In this Section, methods and analysis are proposed to assess or evaluate the power quality impact of using more

power electronics systems and other smart devices into the electrical grid. The two following papers are included in this Section:

- “Impact of modern electronic equipment on the assessment of network harmonic impedance,” by D. Chakravorty *et Al.*, provides a methodology to visualize the impedance variation within a line cycle due to the power electronics switching. Further, three indices are proposed for quantify of this impedance variation.
- “Power quality concerns in implementing smart distribution-grid applications,” by M. Bollen *et Al.*, maps the expected power quality consequences of introducing several smart distribution-grid technologies and applications, such as: microgrids, advanced voltage control, feeder reconfiguration and demand-side management.

### II. CONTROL SCHEMES FOR ENHANCE POWER QUALITY

In order to improve the power quality in microgrids and smart grids, active power filters, inverters and other power electronics based equipment need for superior controllers. This Section includes the following four papers:

- “Design of a thyristor controlled LC compensator for dynamic reactive power compensation in Smart Grid” by C.-S. Lam *et al.*, presents a thyristor controlled LC compensator for dynamic reactive power compensation. Compared with the traditional static var compensators, it can significantly mitigate the injection of harmonic currents.
- “Power Quality Conditioning in LV Distribution Networks: Results by Field Demonstration,” by H. Hafezi *et al.*, proposes a new system solution to improve the PQ level in LV distribution networks given by the use of an Open Unified Power Quality Conditioner. It consists of a single or three-phase AC/DC power converter installed at customer side and a single/three-phase AC/DC power converter in the MV/LV substation.

- “Using Smart Impedance to Transform High Impedance Microgrid in a Quasi-infinite Busbar,” G. Lambert-Torres *et al.*, the use of a smart impedance, an application of a hybrid active power filter, is proposed to change the microgrid bus impedance forcing it to behave as a quasi-infinite bus, without increasing active power capacity of the microgrid.
- “Centralized Control of Distributed Single-Phase Inverters Arbitrarily Connected to Three-Phase Four-Wire Microgrids” by D. Brandao *et al.*, proposes a technique to control the power flow among different phases of a three-phase four-wire distribution power system by means of single-phase converters arbitrarily connected among the phases. The objective is to improve the power quality at the point-of-common-coupling of a microgrid, to enhance voltage profile through the lines, and reduce the overall distribution losses.

### III. ADVANCES METHODS FOR POWER QUALITY ASSESSMENT

The assessment of power quality through smart meters and phasor measurement units is a new powerful tool in smart grids. Two relevant papers are included in this Section:

- “Syncretic use of smart meters for Power Quality monitoring in emerging networks” by M. Albu *et al.*, proposes an alternative PQ-framed aggregation algorithm to be implemented in smart meters. In this way smart metering can become enabler of real-time voltage control required in active distribution grids.
- “A Fast Harmonic Phasor Measurement Method for Smart Grid Applications” by S. Jain *et al.*, proposed a parametric method, estimation of signal parameters using rotational invariance technique has been used to estimate harmonic phasors applied to the IEEE Std. C37.118.1 for synchrophasors.

### IV. SYNCHRONIZATION TECHNIQUES

Finally, the synchronization of power electronics converters in microgrids is crucial to reconnect those small grid systems to the smart grids, and presented in the following paper:

- “Synchronization of power inverters in islanded microgrids using an FM-modulated signal” by I.

Patrao *et al.*, a synchronization technique is proposed based on frequency modulation to be transmitted thus being robust against noise. The demodulation is performed with low computational load to synchronize the grid-forming power electronics converters of a microgrid.

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His research interests are oriented to different microgrid aspects, including power electronics, distributed energy-storage systems, hierarchical and cooperative control, energy management systems, smart metering and the internet of things for AC/DC microgrid clusters and islanded minigrids; recently specially focused on maritime microgrids for electrical ships, vessels, ferries and seaports. Prof. Guerrero is an Associate Editor for the IEEE TRANSACTIONS ON POWER ELECTRONICS, the IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS, and the IEEE Industrial Electronics Magazine, and an Editor for the IEEE TRANSACTIONS ON SMART GRID and IEEE TRANSACTIONS ON ENERGY CONVERSION. He has been Guest Editor of the IEEE TRANSACTIONS ON POWER ELECTRONICS Special Issues: Power Electronics for Wind Energy Conversion and Power Electronics for Microgrids; the IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS Special

Sections: Uninterruptible Power Supplies systems, Renewable Energy Systems, Distributed Generation and Microgrids, and Industrial Applications and Implementation Issues of the Kalman Filter; the IEEE TRANSACTIONS on SMART GRID Special Issues: Smart DC Distribution Systems and Power Quality in Smart Grids; the IEEE TRANSACTIONS on ENERGY CONVERSION Special Issue on Energy Conversion in Next-generation Electric Ships. He was the chair of the Renewable Energy Systems Technical Committee of the IEEE Industrial Electronics Society. He received the best paper award of the IEEE Transactions on Energy Conversion for the period 2014-2015, and the best paper prize of IEEE-PES in 2015. In 2014, 2015, and 2016 he was awarded by Thomson Reuters as Highly Cited Researcher, and in 2015 he was elevated as IEEE Fellow for his contributions on “distributed power systems and microgrids.”